355. “Predicting the future”: the impact of reference values on a range of respiratory parameters

P3198
All-age multi-ethnic reference values for spirometry: The global lung function initiative (GLI)
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Background: The GLI (an ERS Task Force) was established to develop the first global reference equations for spirometry. These are the result of unprecedented international cooperation and are endorsed by six international respiratory societies, including the ERS.

Methods: Data from 74,187 healthy non-smokers aged 3-95 years were used to derive reference equations using modern statistical methods, including development of age-dependent lower limits of normal.

Results: All-age reference equations are now available for Caucasians, African Americans, South East Asians (south of the Huaihe River and Qinling Mountains), and North East Asians (north of the Huaihe River and Qinling Mountains). For individuals not represented by these four groups a composite equation is provided. Since the observed ethnic differences were proportional to Caucasians, for groups not represented, samples of healthy subjects, composed of at least 300 individuals, studied according to international standards (Quanjer et al ERJ 2011, 37; 658-664) and with height and age measured accurately to one decimal place (Quanjer et al, ERJ 2012, PM:22183491), can be used to validate the GLI and/or create an appropriate adjustment factor (www.lungfunction.org).

Conclusions: The GLI 2012 reference equations are a major step forward and provide a robust reference standard to streamline interpretation of spirometry across all-ages worldwide. Widespread use of the GLI equations will, however, depend on timely implementation by manufacturers of spirometric devices.

P3199
A comparative study of FVC, FEV1, and TLC in non-smoking Saudi students at Eastern Province, Saudi Arabia with Caucasian reference values
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Introduction: It is well-known that pulmonary function testing (PFT) values vary with height, age, gender, and ethnicity.1 The influence of ethnic variation on PFT in particular has been the topic of numerous studies conducted globally.1,2 In Saudi Arabia (SA), the currently available reference values (RV) for PFT are based on data from the Caucasian population. We aimed to compare Saudi measured values,
for forced vital capacity (FVC), forced expiratory volume in one second (FEV₁) and total lung capacity (TLC), with Caucasian RV.

Methods: Healthy non-smoker university students were recruited to perform spirometry and plethysmography. Measurements were obtained according to ATS/ERS recommendations, standardized for height and age and compared with Caucasian RV.

Results: We studied 128 subjects, 16 of which were excluded for technical reasons. Significant difference (p<0.01) was found between the measured values in Saudis (52 males and 60 females) and Caucasian RV. The means for the measured values of FVC, FEV₁ and TLC for Saudis were found to be lower than the means of RV for Caucasians by about 10%, 5% and 8% respectively for males and 16%, 12% and 5% respectively for females.

Discussion: Matching the reference and patient populations when selecting RV for PFT is significant. The observed differences we found between Saudi’s PF and Caucasian RV can be deemed of great importance and maybe explained in terms of environmental and life-style factors. However, larger study is required to confirm these findings.

References:

P3200
Reference values for spirometry in healthy subjects 17 to 25 years
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Background: Spirometry is the most common way to evaluate pulmonary function. The European Respiratory Society recommends the development of new reference equations, in order to upgrade and improve the existing ones.

Aim: Develop reference equations to calculate reference values adjusted to a healthy population of college students.

Methods: A total of 49 healthy female individuals with ages ranging from 17 to 25 years old were enrolled in the present study. A standardized respiratory and allergy symptoms questionnaire was applied and spirometry was performed in the selected individuals. FEV₁, FVC and FEV₁/FVC were used as dependent variables in simple and multivariate linear regression models.

Results: Height is the variable that best explains variation of FEV₁ ($r^2 = 0.36; p < 0.001$) and of $\text{FVC}$ ($r^2 = 0.50; p < 0.001$), while weight is the variable that best explains FEV₁/FVC ($r^2 = 0.15; p = 0.006$). Knudson’s equations were the most different from this model, while Quanjer’s were the closest.

Conclusions: The effect of body composition on pulmonary function
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2Internal Medicine, Yeungnam University College of Medicine, Daejeon, Korea.

Background: The pulmonary function test (PFT) is the most basic test methods to diagnosis lung disease. The purpose of this study was to research correlation of the body mass index (BMI), the fat percentage of the body mass (Fat%), the muscle mass, the fat-free mass (FFM) and the fat-free mass index (FFMI), waist-hip ratio (WHR) on the forced expiratory volume curve.

Abstract P3202 – Table 1

<table>
<thead>
<tr>
<th>Klement (1)</th>
<th>ECCS (2)</th>
<th>NIHANES III (3)</th>
<th>Cohen’s Kappa</th>
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<tbody>
<tr>
<td>1-2</td>
<td>2-3</td>
<td>1-3</td>
<td></td>
</tr>
<tr>
<td>Normal FEV₁/FVC ≥0.7; FVC ≥80%Pred; FVC ≤LLN</td>
<td>2978 (0.38)</td>
<td>3146 (0.40)</td>
<td>2383 (0.31)</td>
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<tr>
<td>FEV₁ ≤40%Pred</td>
<td>3586 (0.40)</td>
<td>3415 (0.44)</td>
<td>2301 (0.30)</td>
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<tr>
<td>Obstruction: FEV₁/FVC &lt;0.7</td>
<td>2705 (0.36)</td>
<td>2710 (0.35)</td>
<td>2855 (0.37)</td>
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<td>FEV₁ ≤40%Pred</td>
<td>2906 (0.32)</td>
<td>2508 (0.32)</td>
<td>2836 (0.36)</td>
</tr>
<tr>
<td>Restriction: FEV₁/FVC ≥0.7</td>
<td>1247 (0.16)</td>
<td>1089 (0.14)</td>
<td>2035 (0.26)</td>
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<td>FVC ≤80%Pred</td>
<td>764 (0.10)</td>
<td>921 (0.12)</td>
<td>2160 (0.28)</td>
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<tr>
<td>Mixed %Pred</td>
<td>799 (0.10)</td>
<td>834 (0.11)</td>
<td>506 (0.06)</td>
</tr>
<tr>
<td>FVC ≤50%Pred</td>
<td>903 (0.12)</td>
<td>935 (0.12)</td>
<td>482 (0.06)</td>
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</tbody>
</table>

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Method: Between March and April 2009, a total of 291 subjects were enrolled. 152 men and 139 female (mean age: 46.3±9.92) were measured the FVC, FEV1, FEF25-75, from the forced expiratory volume curve by the spirometry and the body composition by the bioelectrical impedance method. Correlation and multiple linear regression between body composition and pulmonary function were used executed.

Result: BMI and Fat% had no correlation with FVC, FEV1, in male, but FFMI is positively correlation. In contrast, BMI and Fat% had correlation with FVC, FEV1, in female, but FFMI had no correlation. Both male and female, FVC and FEV1, had negative correlation with WHR (male range FVC r=-0.327, FEV1, r=-0.36; p-value<0.05) (female rVC=0.175, rFEV1, r=0.213; p-value<0.05).

In a multiple linear regression of considering body composition at total sex group, FVC was explained FMM, BMI, FFMI in order (R²=0.579, 0.657, 0.663), FEV1 was explained only Fat% (R²=0.011), FEF25-75 was explained muscle mass, FFMI (R²=0.126, 0.138, 0.148).

Conclusion: The BMI, Fat%, muscle mass, FFMI, WHR have significant association with pulmonary function but R² (coefficient of determination) were not high enough for explaining lung function.

P2306

Impact of a pulmonary laboratory quality control oversight on continual improvement

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Introduction: The purpose of this study was to evaluate the impact of a quality control (QC) oversight program on compliance with QC, biological coefficient of variation (CV) targets, and test performance improvements.

Methods: The Diagnostic Accreditation Program (DAP) of British Columbia is responsible for accrediting 27 pulmonary function (PF) laboratories representing 45 testing systems throughout the Canadian province. In 2008 DAP elevated the required elements of their quality assurance program to be more consistent with the current ATS-ERS recommendations for QC testing. This included increasing the frequency of the biological testing and adding a diffusing capacity mechanical QC model. DAP also changed the data review model to include assessment by an external consultant with a feedback report process to the sites. We compared the data through 2011 to assess the impact of the feedback process. Data were categorized into major and minor subsets for compliance. BioQC targets, and test performance based on an assessment of overall impact of the deficiency on lab performance (e.g. BioQC DLCO CV target < 5%, a CV > 5-10 categorized as major; CV > 10% a major deficiency).

Results: There was a significant improvement in all three areas of the monitoring program with a total improvement of 61% (p<0.05). Using a formal external oversight process which includes written feedback appears to improve the overall outcome of this regulated quality assurance program.

P2307

Validation of spirometer calibration syringes

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The calibration syringe is probably the most important instrument in pulmonary function laboratories, yet no validation results have been published.

Methods: We weighed a 3 L calibration syringe over a 5-year period. A total of 984 standardized respiratory and allergy symptoms questionnaires were collected, allowing the selection of 50 healthy subjects, which carried out tests of EBT. Simple and multivariate linear regression between body composition and pulmonary function were used to determine factors and reference values.

Aim: Establish reference equations for EBT.

Background: Exhaled Breath Temperature (EBT) is a potential new method for diagnosis and management of respiratory diseases. However, there are few studies showing determinant factors or reference values.

Methods: A total of 984 standardized respiratory and allergy symptoms questionnaires were distributed and collected, allowing the selection of 50 healthy subjects, which carried out tests of EBT. Simple and multivariate linear regression analysis was used to obtain reference equations and for determining the variables that were expected to influence the values.

Results: Height is the model that best explains the variation of EBT (r2=0.25, p<0.001). There was a weak but significant correlation between EBT and FVC and FEV1 (r=0.3, p=0.036). There was no significant difference between the values obtained in healthy individuals compared to other studies, but there was a significant difference when compared to asthmatic subjects.

Discussion: EBT is affected by height, which can also be related to lung volumes. Defining reference equations may help explore the potential of EBT as a simple, inexpensive and easily applied biomarker in clinical practice.
The comparison study on the effects of high vs. low flux membrane on pulmonary function tests in hemodialysis patients
Aly Momeni, Hamid Roshan Ronoujeni, Glaheh Kiani, Massoud Amari. Internal Medicine Department, Shahrekord University of Medical Sciences, Shahrekord, Chaharmahal va Bakhtiar, Islamic Republic of Iran

Conclusion: Since high flux membranes are more expensive than low flux membranes, and there was no significant difference in the results of spirometry on patients, it could not be offered the use of high flux membrane for this purpose.

P3209 Pulmonary volumetric analyses based on three-dimensional computed tomography (3D-CT) compared pulmonary function test
Hirono Mogi1, Sayaki Hiratsuka1, Kako Moeta1, Masamichi Koyanagi1

Results & discussion: Lung volumes (LV), as well as the low attenuation volume (LAV), were measured based on 3D-CT both at the end inspiratory volume (EIV) and end-expiratory volume (EVE) and compared with the physiological data of ordinary pulmonary function tests. Results showed a significant difference between the values measured using 3D-CT and the conventional pulmonary function test.

P3210 A new ultrasonographic device for within-breath measurements of diaphragm thickness during breathing
Daniele Ronga, Alberto Biancardi, Giorgio Gobetti, Marriana Laviola, Barbara Uva, Rita Prioti, Andrea Aliverti. Dipartimento di Biosingegneria, Politecnico di Milano, Milano, Italy

Results: The ultrasonographic device was able to detect the small changes of DT during quiet breathing; b) allows an operator-free method to monitor DT during breathing and to study different patterns of DT variations, corresponding to different timing of diaphragm activation.

P3211 Estimation of chest-wall mechanics by laser self mixing interferometer
Hari Mekles1, Emanuela Zannin3, Peter Kostic1, Michele Norgia1, Chiara Veneroni1, Antonello Moriconi1, Peter Frykholm1, Rafaille Della1
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Results: The impedance averaged maps in the figure below show high spatial inhogeneities, in particular one may appreciate that at 5 Hz it is possible to identify the region of the rib cage, where the pressure stimulus moves fast, and the abdomen where the pressure wave is slowed down by the high inertive component.

P3212 Specificity and sensitivity of the methacholine challenge test for the diagnosis of asthma in athletes
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The report of recurrent symptoms of bronchial obstruction as chest tightness, wheeze and cough provoked by exercise is a prerequisite for the diagnosis of asthma or exercise-induced bronchospasm (EIB) in athletes. The report of symptoms should be verified by the demonstration of reversibility of airflow obstruction, EIB or other methods of diagnosing either indirect or direct bronchial hyperresponsiveness (BHR). The purpose of this study was to examine specificity and sensitivity of the methacholine challenge test (MCT) for the diagnosis of asthma in athletes.

Twenty seven athletes (16 M/11 F, mean age 22.0±4.3 yrs) with respiratory
symptoms were studied. Lung function with assessment of reversibility to salbu-
tamol (n=27) and challenge tests with methacholine (n=25) were performed. The
specificity and sensitivity of the MCT were evaluated.
Significant reversibility to salbutamol was found in 7 athletes. The fall in forced
expiratory volume in one second (FEV1) following the methacholine inhalation
(≤ 8 mg/ml) was more than 20% in 16 athletes (30.3±9.6% vs 12.3±7.1% in
nonresponders (n=9), p<0.0001). The MCT-BHR test showed high specificity
(100%), but a lower sensitivity (80%) and negative predictive value (55.6%). At
the moderate BHR cutoff value (≤ 4 mg/ml), the MCT-BHR test had a more low
sensitivity (70%) and negative predictive value (45.5%). Assessment of bronchial responsiveness by a direct method (bronchial provocation
with methacholine) is a good procedure of diagnosing asthma in athletes. The
MCT-BHR test in athletes with respiratory symptoms had a high specificity and
sensitivity and cutoff value for high BHR may be more useful.

P3213
Bronchial hyper-reactivity diagnosed by methacoline challenge and the
pre-test clinical probability
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Bucharest, Romania

Aim: To assess the correlation between methacoline challenge results and the
pre-test clinical probability of bronchial hyper-reactivity.

Subjects and methods: Patients with respiratory symptoms raising suspicion of
asthma and patients with partially controlled asthma performed methacoline chal-
lenge (MC) using ATS Guidelines (1999). The test was considered negative for a
PC20 >16 mg/mL and borderline for 8-16 mg/mL. Bronchial hyper-reactivity was
considered severe for PC20 <0.125 mg/mL.

Pre-test probability of bronchial hyper-reactivity was recorded by the pulmonolo-
gists using visual analogic scale (VAS) based on history, clinical findings and
previous spirometry results; the scores ranged from 0 (no hyper-reactivity) to 10
doubtless hyper-reactivity).

Results: 50 patients were evaluated. VAS scores and PC20 values differed signifi-
cantly in the two groups:
– In the 26 patients with known asthma VAS scores were 5.1-10 (mean 7.6). MC
showed moderate or severe bronchial hyper-reactivity in all subjects, with PC20
0.03-2 mg/mL (mean 0.56).
– In the 24 patients with suspicion of asthma VAS scores were 0.9-9 (mean
4.8). MC was negative in 13, borderline in 2 patients and showed bronchial
hyper-reactivity in 9 (severe in 1, moderate in 5, mild in 3 patients; mean PC20
5.3).

A strong correlation was seen between VAS pre-test scores and PC20 values in
the suspicion of asthma group (r=-0.832, p<0.000) and a weak correlation in the
known asthma group (r=-0.389, p=0.049).

Conclusions: Pre-test clinical probability of bronchial hyper-reactivity recorded
by the pulmonologists on visual analogic scale correlated well with the PC20
values at methacoline challenge in patients with suspicion of asthma.